HISINGERITE.

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Two hydrous silicates of ferric iron are known in nature—Nontronite and Hisingerite. Of these, the former has been recorded from many different parts of the State including Westonia,[*] but the latter, which is a much less common mineral, has not previously been observed. In fact, Anderson's *Bibliography of Australian Mineralogy* shows that up till 1916, at least, it had not been recorded from any part of the Commonwealth.

Recently, through the courtesy of H. G. Stokes, Esq., of Westonia, and A. Montgomery, Esq., State Mining Engineer, I have received specimens of hisingerite from that centre. Mr. N. S. Stuckey, Mine Manager, says that the chief occurence is at the 740ft. level of the Edna May Deeps Gold Mine along a joint plane cutting the quartz reef at right angles to its strike. The upper water level is at a depth of only 75ft. and although the main rock masses (granodiorite gneiss and amphibolite) are quite unweathered at 740ft., distinct evidences of weathering are apparent along this joint plane. The occurrence of hisingerite considerably below the surface at a position of incipient weathering coincides with the occurrence of nontronite prevailing throughout the Western Australian Goldfields.

The mineral at the 740ft. level is found in small masses and lenses associated with vein quartz, siderite, a little pyrite, and some indefinite products of rock weathering, possibly including saponite. The creamy white siderite is found not only in small masses in contact with the hisingerite but also, to a slight extent, scattered in granules through it. Two other small specimens from the 676ft. level of the same mine show small crusts of hisingerite and siderite: in one case coating massive pyrrhotite, in the other coating massive and crystallised marcasite with quartz. It is possible, therefore, that the silicate is a replacement of the carbonate, dilute sulphuric acid from the oxidation of the sulphide serving to upset the equilibrium originally prevailing. No evidence is available on which to form a definite explanation of the origin of the hisingerite. Tentatively I would suggest—

$$2FeCO_3 + O + 2(SiO_2 \cdot 3H_2O) = (Fe_2O_3 \cdot 2SiO_2 \cdot 2H_2O + 2H_2O) + 2H_2CO_3.$$

In this reaction dilute sulphuric acid acts as a catalyst, the precipitation taking place in an almost neutral solution.

The mineral is typical in appearance. It is apparently amorphous,[†] dense and structureless, with a conchoidal fracture and res-

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[*] E. S. Simpson: The Minerals of Westonia. G.S.W.A. Bull. 71, p 243 (1917).

[†] Sustschinskey's microscopic study of various specimens of hisingerite showed that they were cryptocrystalline. Zeit. Kryst. 47, 231 (1909).

inous lustre. It is opaque (1mm.) with a brownish black colour. Under the microscope the fine powder is translucent and reddish-brown in colour. Most of the fragments are isotropic, but some are strongly birefringent, indicating the association of a small amount of cryptocrystalline matter with a colloid. The masses are very brittle and are penetrated in every direction by minute cracks, probably shrinkage cracks due to dehydration. The density given by Dana is 2.5 to 3.0, but a careful determination of the density of the Westonia mineral gave for four small (2 to 4mm.) fragments, 2.26, 2.26, 2.27, 2.28: the mean being 2.27. These determinations were made by diluting methylene iodide, using quartz (2.65), selenite (2.32) and opal (2.10) as indicators.

The chemical composition sheds light on this low density. Some apparently almost clean mineral was taken for a rough analysis. This was found to be rapidly decomposed by cold 5E hydrochloric acid, the iron going into solution and gelatinous silicic acid, in the form of the original mineral fragments, remaining. Treatment in this way revealed embedded granules of siderite amounting approximately to five per cent. of the whole. The analytical results obtained were—

Fe_2O_3	36.8	per cent.
SiO_2	31.6	"
H_2O above 100°	6.0	"
H_2O at 100° ..	21.8	"

Allowing for the siderite these are not unlike Dana's figures,[*] the ratio of SiO_2 to Fe_2O_3 being approximately 2 to 1, but the water is distinctly higher, Dana's average being 21 per cent. The material analysed had been exposed to the air in the author's laboratory for several weeks before analysis, but had not been long out of the mine, and with lapse of time might well have lost more water before reaching a condition of equilibrium in air. The extra water, which is all lost rapidly at 100°, accounts for the low density.

The chemical composition of hisingerite has not been definitely settled. Hintze[†] does not look upon it as deserving of specific rank. He says—

"Amongst the hydrous amorphous silicates there is scarcely one to be found which can be considered as a 'mineral,' that is, as a chemical compound or isomorphous mixture. . . . .

"A second section of hydrous substances consists essentially of ferric silicate, partly of lighter, mostly green, colour, such as the chloropal of Unghvar in Hungary, partly of brownish black to black colour, such as the hisingerite of Riddarhytten in Sweden: the black as a rule of greasy lustre, dense with conchoidal frac-

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[*] System of Mineralogy, 1896, Ed., p. 702.

[†] Handbuch der Mineralogie, II., pp. 1827, 1830.

ture. . . . In general these iron silicates are plainly still less homogenous, and on this account still more variable in composition than the aluminium silicates.''

Further, he quotes Knop as holding that some of these supposed iron silicates are only mixtures of iron hydrate with quartz or opal.

Dana on the other hand,[‡] without being able to ascribe to hisingerite a definite formula, accords it full specific rank, as also does Lacroix.[§] This attitude is amply justified by the closely concordant ratios existing between Fe_2O_3, SiO_2, H_2O+ and H_2O- in specimens from widely separated localities.

E. Weinschenk many years ago suggested[||] that nontronite is the homologue of kaolinite, its true formula being

$$Fe_2O_3 \cdot 2SiO_2 \cdot 2H_2O.$$

Chloropal is then a mixture of nontronite with more or less opal.

Reviewing the analyses and chemical and physical properties of hisingerite it appears to the author that this mineral is a distinct species, the homologue of halloysite. Its formula then is—

$$Fe_2O_3 \cdot 2SiO_2 \cdot 2H_2O + 2H_2O,$$

with which further absorbed water is associated at times, *e.g.*, in the Westonia mineral. This formula requires

Fe_2O_3	45·4	per cent.
SiO_2	34·2	,,
H_2O+	10·2	,,
H_2O-	10·2	,,

[‡] Loc. cit.

[§] Miner. de la France I., p. 405.

[||] Zeit. Kryst. 28, 150 (1897).